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Structural Defects

influencing

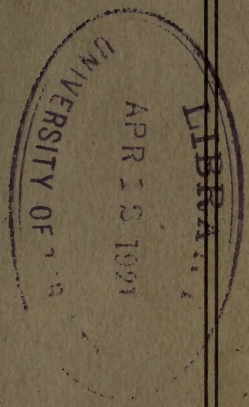
The Spread of Fire

Suggestions

for their

Elimination and Protection

Prepared by the
Committee on Manufacturing Risks
and Special Hazards



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NATIONAL FIRE PROTECTION ASSOCIATION
EXECUTIVE OFFICE, 87 MILK ST.
BOSTON, MASSACHUSETTS

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Membership in the National Fire Protection Association is open to any *Society, Corporation, Firm* or *Individual* interested in the protection of life or property against loss by fire.

All the valuable *engineering* and *popular* literature issued by the Association is sent, as issued, to every member.

The Association is the clearing house for all the authoritative information on Fire Protection and Prevention and members are privileged to submit to it their individual problems for solution.

The Association is always glad to send samples of its publications to prospective members.

Structural Defects

Suggestions for their Elimination and Protection

Presented at Annual Meeting, 1916

Revised and Reprinted, 1916, 1921

Prepared by

National Fire Protection Association

COMMITTEE ON

MANUFACTURING RISKS AND SPECIAL HAZARDS.

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Foreword

In all new construction the Building Code of the National Board of Fire Underwriters should be followed so far as possible. Local representatives of the Underwriters will gladly look over preliminary plans without cost and will make suggestions and furnish other information relative to insurance costs, safety from fire, or danger to life, and will freely give their general experiences relating to any particular new work to be undertaken.

Buildings already constructed often contain marked structural defects which usually can be easily corrected or protected. This pamphlet points out how such defects can be eliminated or made comparatively safe. The suggestions and sketches are designed primarily to cover defects in buildings of ordinary construction, but the same principles may be applied to like faults which are often found in fire resistive buildings. As a general rule, partitions enclosing vertical openings should be made of material equivalent in fire resistance to that of the floors of the buildings so for fire resistive buildings some form of fire retardent partition should be always used.

It is most important that fires be confined to the rooms in which they start, that they may be readily extinguished. Any openings from a room

into the hollow spaces between the walls, floors or roofs may permit fire to enter such concealed spaces and spread where it cannot be reached by hose streams or sprinklers.

Fire usually spreads much faster vertically than horizontally and for that reason it is most important that it have no open path from the room in which it starts to rooms above, and that there be no openings in the floor through which burning embers may drop, spreading the fire in the story below. Such openings permit a rapid destruction of a building by a fire and their protection is imperative to safeguard both the building and the lives of its occupants.

The suggestions herein cover the best methods of guarding the several defects pointed out and it is hoped that they will aid property owners in coöperating to reduce the excessive fire waste.

SHINGLE ROOFS.

Any kind of a roof is safer than a wooden shingle roof. Other roofs may burn, but they will not ignite from sparks, and will not furnish flying brands. The wooden shingle is a notorious conflagration breeder. It furnishes both the firebrand, and the tinder which it ignites.

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NOTE: For safeguarding dwelling-house hazards see "Dwelling Houses" published by National Board of Fire Underwriters; also "Field Practice," inspection manual of the National Fire Protection Association and "Construction of Chimneys" (1920).

1.

SHEATHING AND PLASTERING.

1. Hollow spaces formed by sheathing or plastering behind which fire may spread are most objectionable. Where the sheathing boards or laths are nailed directly to the bottom of the joists, as in Fig. 1, there is less danger than where the sheathing is offset by furring or other nailing strips fastened at right angles to the joists, as in Fig. 2. In the former case fire can travel easily in only one direction, between the joists, while in the latter case a fire can spread all over the concealed space.

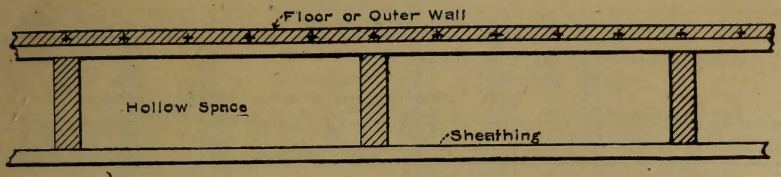

FIG. 1.

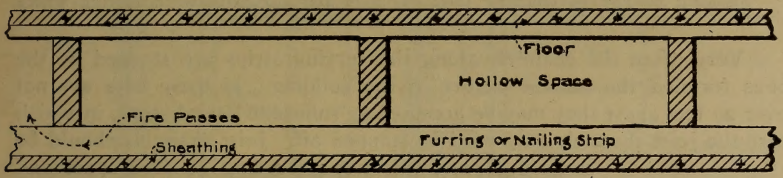

FIG. 2.

Showing sheathing nailed to furring which forms a channel permitting fire to pass under and across the joists as well as parallel to them.

To prevent the spread of fire through hollow spaces, they must be "stopped off" by inserting boards or by filling the channels with concrete or bricks and mortar. The use of the non-flammable materials is of course preferable, as they will stop both fire and rats and mice.

By removing base boards the wall channels can be readily stopped off at each floor after which they may be replaced. For ceilings it is necessary to remove a strip of the sheathing or floor boards to insert the stops.

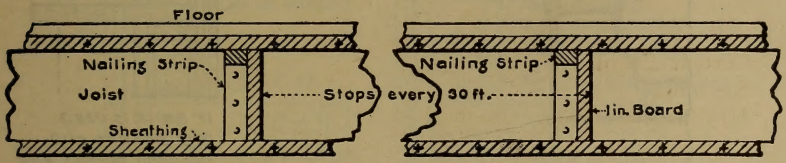

FIG. 3.

Showing method of "stopping" joist channels, where sheathing is fastened directly to joists.

2. For stopping the joist channels where the sheathing is nailed to the joists, as in Fig. 1, it is necessary to insert boards cut to fit tightly the rectangular space between the joists as shown in Fig. 3. To make a tight joint, strips to which the boards are nailed are first nailed to the joists and floor as shown. In replacing the sheathing it should be fastened tightly to the bottom of the new inserts.

In stopping off wall spaces of this kind, 2-inch plank stock or double boards should be used.

3. Where the sheathing is fastened to nailing strips or furring, both the longitudinal channels between the joists and the cross channels formed between the furring strips must be stopped off. The safest way to eliminate this defect is to entirely remove the sheathing and furring strips, replacing the sheathing, if it must be retained, directly on the joists without using the furring, then inserting stops as suggested above.

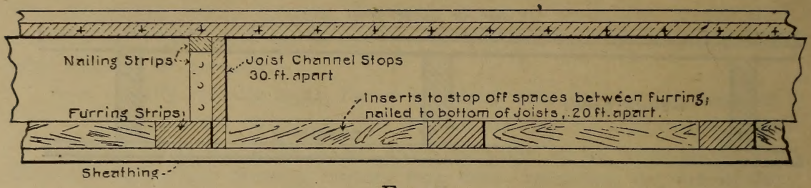

FIG. 4.

Showing method of stopping joist channels and spaces between furring where sheathing is fastened to nailing strips running across joists.

Very often the channels along the furring strips are stopped by the bays forming the main structure of the building. If these bays are not over 20 feet apart they may be accepted as sufficient lateral stops, in which case the joist channels only need be stopped off. Joist channels should be stopped at intervals not exceeding 30 feet apart and cross channel stops should not exceed 20 feet apart. The method is shown in Fig. 4.

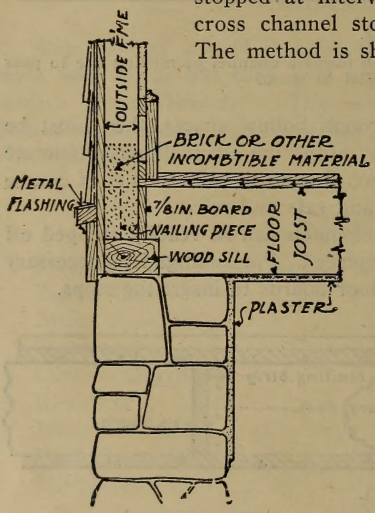

FIG. 5.

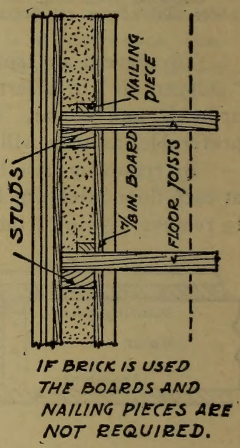

FIG. 6.

Figs. 5 and 6 show the best way of stopping off wall channels by the use of incombustible materials.

4. Many fires start in basements, and it is most important that the open joist channels of the walls be stopped off at the sills to prevent a fire from passing rapidly into the structure above. In most cases, especially in the construction of dwellings, the first floor joists project more or less above the sills, thereby leaving an open path from the basement into the hollow walls.

These spaces preferably should be stopped with concrete or brick and cement, as shown in Figs. 5 to 10, but in some cases it may be permissible to use boards or 2 x 4 pieces as shown in Figs. 11 and 12. Openings between studs at roofs and cornices should be similarly treated to prevent fire passing into attics.

Where filled with mortar the woodwork should first be saturated with a concentrated solution of corrosive sublimate to prevent dry-rot.

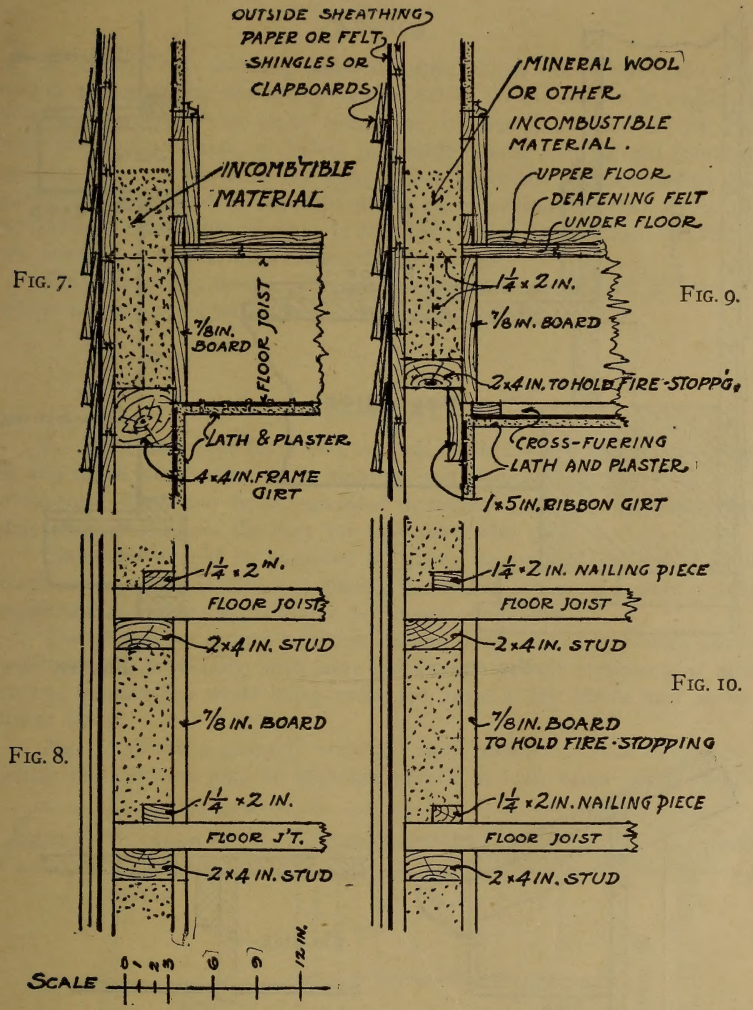

FIG. 7.

FIG. 9.

FIG. 8.

FIG. 10.

Figs. 7 and 8. — Elevation and plan showing fire-stopping in frame wall at connection of upper floor joists with girt.
Figs. 9 and 10. — Fire-stopping at same place for "balloon frame."

2.

BOXED CORNICES.

5. Boxed cornices forming a hollow space inaccessible to hose streams around the eaves of a building are particularly objectionable, as fire in these quickly spreads into the roof, or the ends of the rafters are burned so as to cause the collapse of the roof. In rare cases the roof supports extend into the cornice and entirely fill it so as to effectively stop off the space, but in most cases there is an open space the entire length of the cornice.

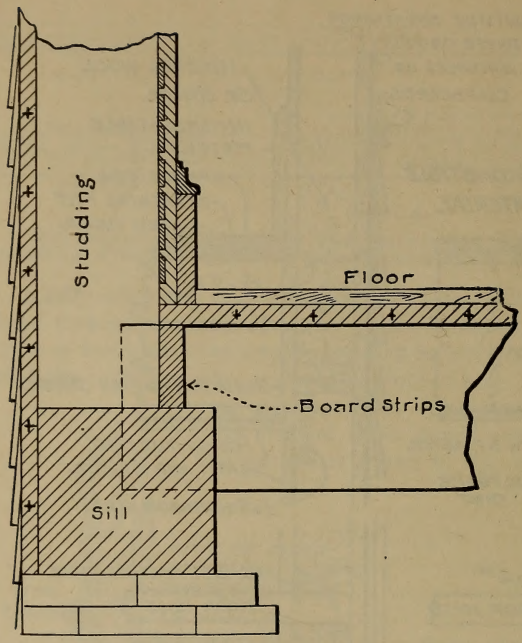

FIG. 11.

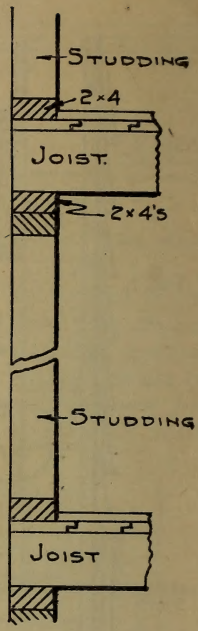

FIG. 12.

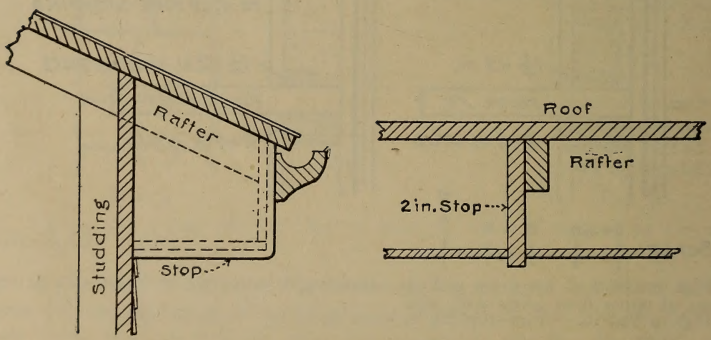

FIG. 13.

If such cornices must be retained they should be stopped off at least every 30 feet with 2-inch plank or non-combustible stops inserted so as to make a tight joint with the walls and roofs. This may be accomplished as shown in Fig. 13, the cornice being sawed through to permit the installation of the inserts.

Where possible boxed cornices should be made open by the removal of the lower boards.

3.

ATTICS.

6. Steep roofs forming attics or other places above the upper story ceiling in a building, always present a defect so far as fire is concerned. Where extensive, these attics should be frequently stopped off by good tight partitions at least equivalent to double boards with lapped joints extending from the floor to the roof. It is especially important that such partitions be located to separate wings or extensions so that a fire may be confined for a time to make it possible to concentrate hose streams on the portion of the building where the fire starts.

This suggestion would apply also to all roof spaces even if very low, where the fire could pass along over the tops of the joists.

4.

STAIRWAYS.

7. Open stairways form free vertical paths for fire and smoke, aiding in the quick destruction of a building and endangering the lives of its occupants. They may be safeguarded in several ways, the local conditions determining which is the best for that particular case.

Stairways should be enclosed in strong partitions, preferably of incombustible material with self-closing fire doors, but good double boarded partitions and doors are suitable for many conditions.

The enclosures should be liberal in size, well lighted both with outside windows and artificially, with wide hallways to permit occupants of upper stories to pass out while being protected from a fire which may be in a lower story.

Fig. 14 shows a properly arranged stair enclosure. The materials of which the partition may be built are named in their order of preference.

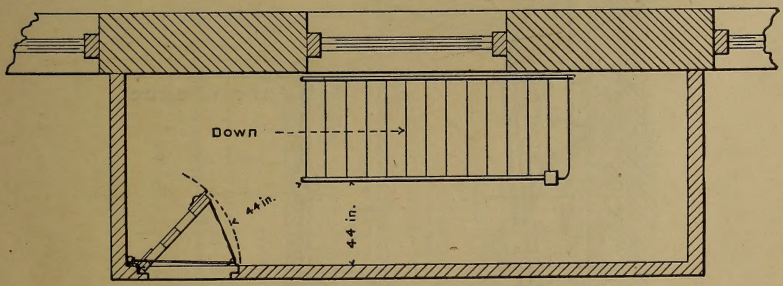

Fig. 14.

a. Brick laid in cement mortar with standard fire doors.

b. Terra cotta, gypsum or cement blocks laid in cement (gypsum for gypsum blocks) with standard fire doors.

c. Cement plaster laid on wire lath or non-combustible wall board to a total thickness of ¾-inch supported on steel, corners and door openings to be reinforced by angle irons: doors to be standard; double matched boards covered with lock-jointed metal.

d. A partition constructed as in section "c," except wood studding to be used instead of steel.

e. Approved non-combustible wall board, doubled, to a total thickness of over ¾-inch with joints plastered, preferably bolted to steel studding. Wood studding, however, is acceptable.

f. Double matched boards with joints "staggered," with doors of the same material, the whole to be painted with non-flammable paint.

8. Doors should swing outward from the rooms and be located near the top of the stairs so that occupants passing down the stairs will not tend to close the door against those coming from the rooms, and so that the latter will not crowd those at the foot of the stairs.

Doors should be made self closing by means of weights hung on chains or by strong springs. Hardware should be of heavy construction and bolted in place. There should be no locks on the doors. If there must be locks, they should be operative without the use of keys, from the room side.

9. There preferably should be no windows in the stair enclosure except in the outer walls. If their presence in the inner partitions or the doors is essential, only approved stationary fire windows (wired glass in standard metal frames) are permissible.

10. Where for particular reasons the standard form of stair enclosure is impracticable, or to protect a building where there are no occupants whose lives must be guarded, stairways may be protected by trap doors made to close automatically by means of fusible links.

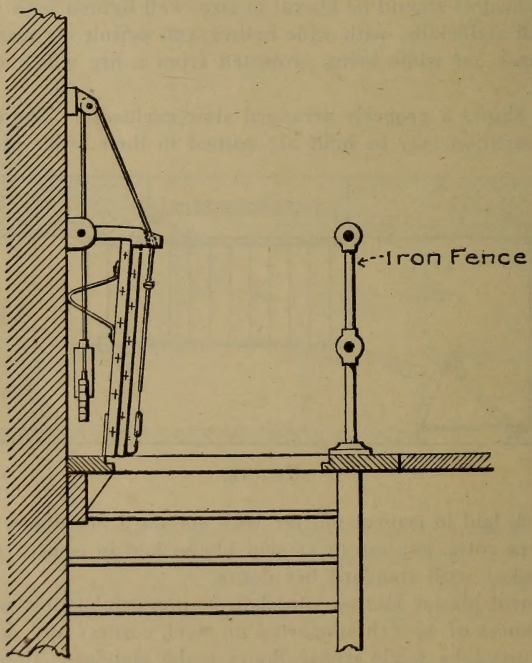

Fig. 15.

Fig. 15 shows a method of protection. The stair opening is guarded by a pipe rail fence on three sides. The trap may be of double matched boards with joints broken or of single boards covered with sheet metal on the lower side and edges.

The trap is held open by an iron or a wood latch to prevent accident. The latch should be located at the end farther from the upper steps. A cord or chain passes through a screw eye or hole in the end of the latch from a fusible link, or preferably a more sensitive heat releasing device, fastened near the floor opening. A knot or projection on the cord trips the latch when the fusible link is parted by heat. This projection should be 6 or 8 inches below the latch so that the weight can fall freely and give a quick blow on the latch.

A projection or other stop should be placed on the top of the trap to keep it away from the wall so that when open it will not pass the centre and prevent closure by gravity.

Under no circumstances should a lock or bolt be placed on such a trap.

To avoid accidents heavy traps should be partially counterbalanced by a weight permanently attached with a wire cable.

11. Another method for the protection of stairways in buildings where there are no occupants whose lives must be guarded is shown in Figure 16.

This is a structure built to enclose the stairs only, there being no hallway around the stairs. The partition extends from the stair threads to the ceiling only. The door and materials of the partition should be as specified in section 6.

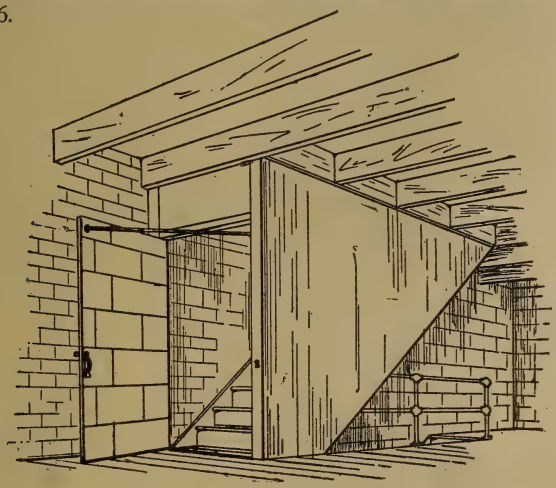

Fig. 16.

5.

CURTAIN BOARDS.

12. Occasionally there may be cases where stairs, hatch ways or other openings cannot be enclosed or trapped on account of peculiar local circumstances.

In such cases some protection may be given such openings by building curtain boards around the opening. These preferably should be of incombustible material forming a tight joint at the ceiling and hanging down 2 feet or, if the height of the story permits, 3 or 4 feet below the ceiling.

Fig. 17 illustrates this form of protection, the curtain being riveted to an angle iron frame work.

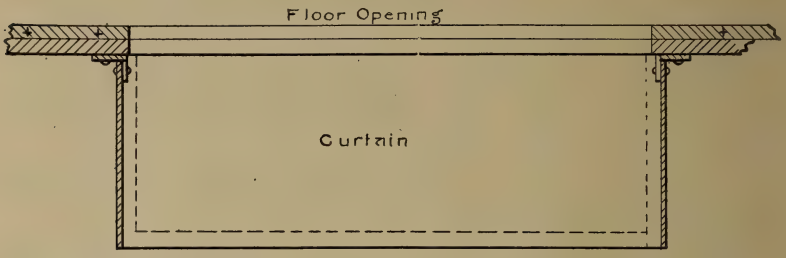

Fig. 17.

A curtain of this form prevents fire and heat, as it flows along the ceiling, from readily passing upward through an opening. In sprinklered buildings it tends to bank up the heat below the sprinklers, causing them to open often before the fire passes around the bottom of the curtain to the room above.

13. A modification of this form of protection is often used to protect the roofs of extremely large areas such as are found in wharves, saw mills, large shops and foundries.

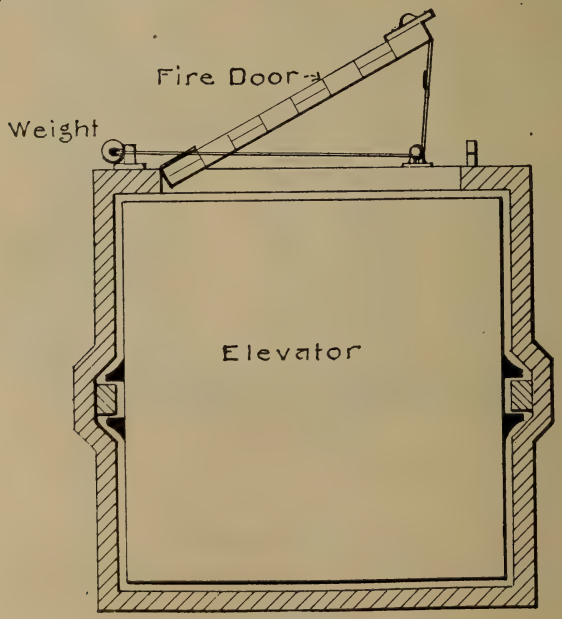

Fig. 18.

By constructing deep curtains extending downward from the roof to within 12 or 15 feet from the floor, the path of a fire running down the roof may be materially retarded. Such curtains should be of non-combustible material. If fastened to roof trusses or timbers, care should be taken that these supports be not overloaded. The curtains if large should preferably be fastened to independent supports.

Due consideration should be given to the fact that these curtains might interfere with the use of hose streams if improperly arranged.

6.

ELEVATORS.

Elevators should be enclosed in wells built as described for stairways; or automatic traps, which open and close as the elevator passes, may be

14. Fig. 18 shows a good arrangement for an elevator well. The sides are built so as to give the shaft a smooth interior, close to the elevator floor, to avoid accidents. The structure should be solidly built of brick, concrete, terra cotta or wire lath and cement plaster according to the conditions and best means available. If of plaster board on wood studding, the shaft should be metal-lined. Openings should be guarded by approved self-closing fire doors.

Care should be taken to tightly close off the tops of all elevator wells. They should never have unprotected openings into attics or hollow roofs. Preferably the roof over elevators should be raised, the well being extended above the main roof. Windows or skylights should be put in the extension above the main roof to ventilate the shaft and serve as a heat and smoke vent. Thin glass, protected on the outside with screens, should be used.

There should be no windows in the elevator shaft or its doors, except in outer walls.

In sprinklered buildings elevator wells should be equipped with sprinklers. (See Sprinkler Regulations).

15. Automatic traps can be installed by any of the elevator manufacturers. The traps should overlap the opening on all sides

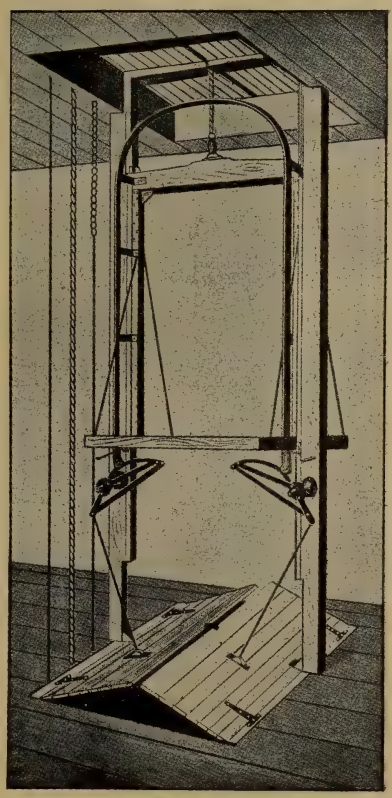

FIG. 19

and fit as closely as possible around the plunger or ropes. Special precautions are necessary to guard trapped elevator openings by fences and automatic gates.

The traps should be made of matched boards with the lower sides and edges covered with lock-jointed sheet metal. Use stronge T-hinges bolted on.

Fig. 19 shows a trapped elevator.

7.

MISCELLANEOUS FLOOR OPENINGS.

Belt Holes.

16. Many fires pass up through floors by means of belt holes. Where there are large belts, such as those from an engine driving several floors of a mill, there have been serious fire losses, as the belts and their openings spread fire readily from floor to floor.

Belts through floors driving light machinery cannot readily be enclosed, but such openings may be protected to some degree by making them as small as possible and erecting curtain boards around them on the ceiling, and by curbing 1 to 2 inches high on the floor. The curtains will prevent the fire and smoke from so readily passing to the room above. The curbing in some measure will prevent water from flowing through the belt hole and will tend to prevent dirt and sweepings getting into the room below. Curbing may be of iron or of wood.

Where belts pass through hollow floors, special care should be taken to stop off the hollow space around the belt hole, to prevent fire passing between the floors and ceiling. Fig. 20 shows how this is done and also shows the suggested curbing and curtain boards.

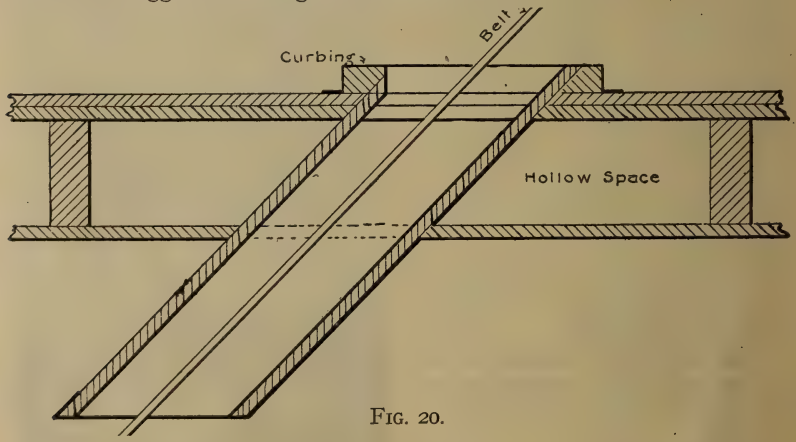

FIG. 20.

Where a line shaft is near the ceiling or, as in a stitching room, near the floor, the floor openings may be efficiently stopped by enclosing the pulley in a metal hood as shown in Fig. 21. Means should be provided for cleaning inside the hood.

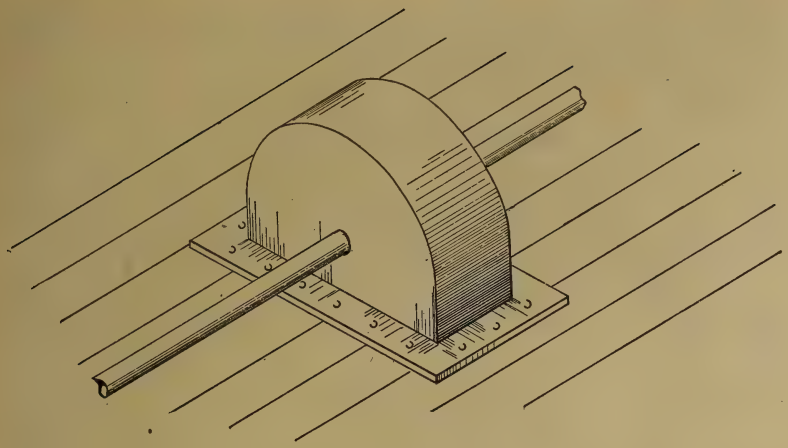

FIG. 21.

17. Where possible, main engine drives and other large belts should be enclosed in brick or non-combustible belt towers. In cases where this is not practical the belts can be enclosed in wire lath and cement structures built fairly closely around the belts, as shown in Fig. 22. The structures shown are built of wire lath and cement plaster supported by 1-inch channel irons spaced 12 inches apart.

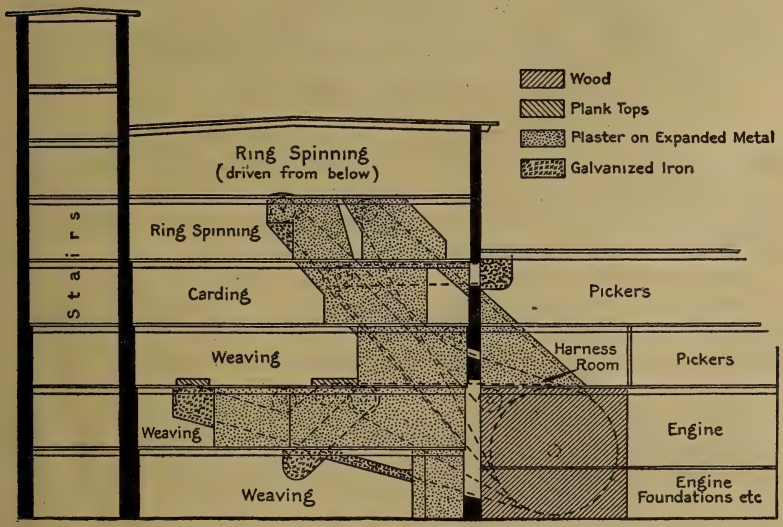

FIG. 22.

These enclosures greatly increase the safety to life and general neatness, as well as successfully safeguard the fire hazard. The enclosures

should be sufficiently large to permit accessibility to the belts, shafting and pulleys for cleaning, and removable panels may be left where necessary to remove pulleys or adjust hangers.

Chutes, Dumb Waiters, etc.

18. Chutes, roller conveyors, etc., should be protected by enclosures, trap doors, with covers operated by fusible links, or curtain boards as the case permits. The methods recommended under "Stairways" and "Elevators" are adaptable to the protection of chutes.

19. Dumb waiters should be enclosed, as are elevators, their entire length with vertical sliding doors made to close automatically with fusible links.

Light Wells.

20. Internal light wells constitute a marked structural defect. If of wood, the walls should be rebuilt of brick, terra cotta or of wire lath and cement plaster on a steel frame.

All windows should be approved fire windows (wired glass in standard metal frames) preferably in fixed sashes, movable sashes to be arranged to close automatically by fusible links.

8.

WALL OPENINGS.

(See Regulations, National Board of Fire Underwriters.)

Openings in Internal Walls.

21. Fire walls prevent the spread of fire horizontally, and, to confine fires as much as possible, every advantage should be taken of existing walls to make them effective fire stops. This can be done by protecting all necessary openings such as doors, windows, shaft holes, etc., and closing permanently all unnecessary openings.

There are standard fire doors of many kinds, designed to conform to all conditions. Fire doors sliding vertically or horizontally, swinging doors, rolling steel doors, are available to meet varying conditions, and have been classed as standard after examination and tests by "Underwriters' Laboratories."

Wood tin-clad doors are in common use for protecting large openings in important fire walls. Solid steel doors are also used for this purpose as well as for smaller openings. Sheet metal and hollow metal doors of various patented forms are also available. Rolling steel doors are available for openings where lack of space prohibits the use of doors of other types. For dwellings, office or public buildings, hollow pressed metal doors or metal-clad doors can be furnished, which are highly finished to imitate woodwork. While ornamental, they are capable of furnishing a fair degree of fire protection.

Fire doors may be made to close automatically by the use of fusible links or other heat operated devices.

For lighting purposes it may be necessary in some cases to retain a window in an internal wall. Approved fire windows (wired glass in standard frames) are available for this purpose. They offer considerable resistance to fire.

Outer Wall Openings.

22. In congested city districts or in other cases where the neighboring exposure is severe, it is important that the outer wall openings of a building be protected against the entrance of fire from the burning of a neighboring building.

For this purpose standard tin-clad, solid steel, sheet metal or rolling steel fire shutters should be used.

For the more moderate exposures standard wired glass fire windows may be used.

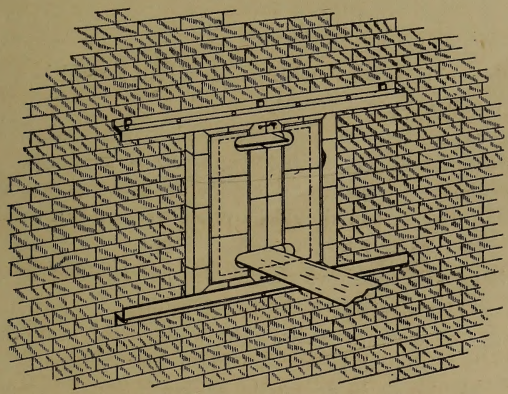

FIG. 23. DOOR TO COVER BELT HOLE OPENING. DOTTED LINES SHOW OPENING THROUGH WALL.

Openings for Belts.

23. These should be protected by two approved sliding doors coming together in the middle of the wall opening. (See Fig. 23). The doors should slide in approved upper and lower guard rails or channels retaining them in place, and be provided with suitable fastenings for holding them together when closed. Where the vibration of the belt is great, the use of guide rollers will permit the use of a smaller slot than otherwise.

Where a pulley is located near a fire wall, with its shaft parallel to the wall and a belt passing through the wall, the opening and pulley may both be covered by a metal hood, as shown in Figs. 21 and 22.

24. Where heating pipes pass in groups through fire walls, and room for expansion and contraction must be maintained, the spaces between the

pipes and the wall may be packed tightly with mineral wool, the opening having been first made as small as practicable.

Openings for Shafting.

25. When a shaft passes through a fire wall the hanger, if any, should be placed on one side of the wall, and the opening around the shaft closed with masonry as completely as possible without touching the shaft. The remaining space around the shaft should be finished with cement mortar leaving one-eighth inch clearance around the shaft.

Shaft openings containing pillow blocks may be protected by steel or tin-clad shutters fitting closely around the shaft. They should be built in conformity to the requirements for standard fire shutters. This method of protection should be used only where absolutely necessary. The substitution of shaft hangers beside the wall, the removal of the wall bearing and the complete closing of the opening as above described is preferable.

9.

SKYLIGHTS.

26. Skylights of plain glass with wooden sash should be replaced with wired glass in metal sash and frame.

Where the exposures are not severe, plain glass skylights may be permitted if protected by galvanized iron screens supported on a metal frame 6 inches above the glass and extending 6 inches beyond the skylight on all sides. The screen should be made of wire not smaller than 12 gauge and have meshes not larger than 1 inch.

Vertical windows in monitors should also be protected by screens, but they may be fastened directly to the outer walls.

Over the tops of elevator wells, light wells, dumb waiters, stairways, etc., no wired glass should be used. Plain glass properly screened is preferred, as it will break in case of a severe internal fire and serve to vent the building.

Before making changes in construction, always first consult the Inspection Department having jurisdiction in your district.

Rich B
W

National fire protection asso
Structural defects influencing
spread of fire

DATE.	NAME OF BORROWER.
June 27/49	F. Bodsworth, 294 Beech Ave.

National Fire Protection Association

(INTERNATIONAL)

Executive Office, 87 Milk Street, Boston, Mass., U. S. A.

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(March, 1921)

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National Association of Insurance Agents.
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